REMR TECHNICAL NOTE CS-MR-8.2

CASE HISTORY OF LOCK REHABILITATION: BRANDON ROAD LOCK, ILLINOIS WATERWAY

PURPOSE: To present a case history of rehabilitation of a navigation lock.

PROJECT: Brandon Road Lock is located on the Des Plaines River about 3 miles south of Joliet, Illinois. The lock is at mile 286 on the Illinois Waterway. Constructed in 1928, the 110-ft-wide by 600-ft-long lock was shut down on 5 July 1984 for rehabilitation.

REHABILITATION: James McHugh Construction Co., Chicago, Illinois, was low bidder for Stage I rehabilitation of Brandon Road Lock. Bids ranged from $7.96 million to $12.26 million compared to the government estimate of $14.80 million. Principal features of the Stage I rehabilitation included:

a. Upper guide wall resurfacing.

b. Upper gate bays resurfacing.

c. Lock chamber resurfacing.

d. Lower gate bays resurfacing.

e. Lower gate forebays resurfacing.

f. Stairway resurfacing.

g. Stabilization and resurfacing of lower guide wall.

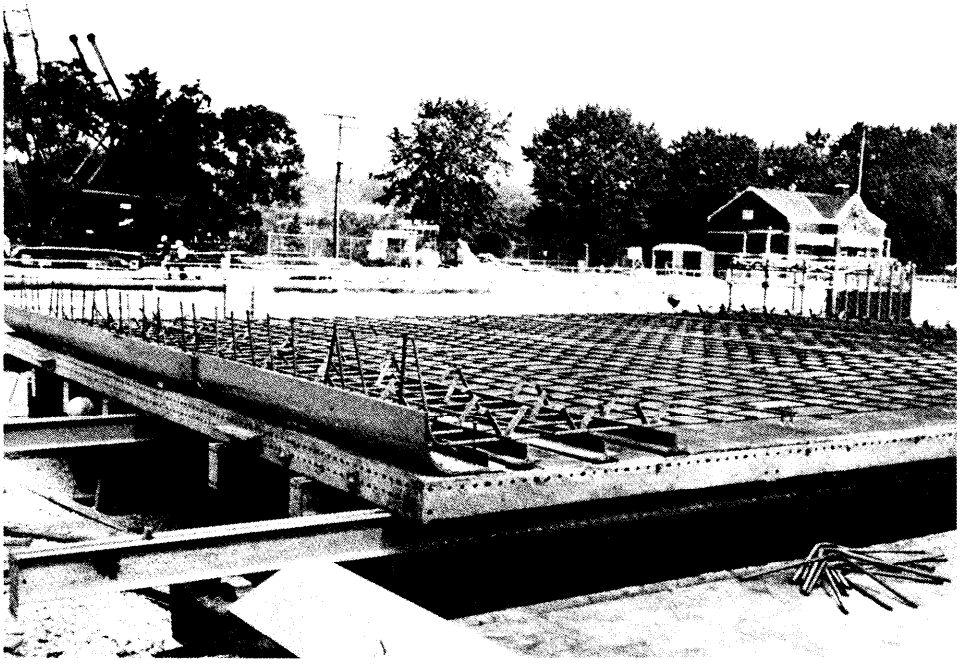
h. Lower guide wall cell replacement.

i. Rehabilitation of upper guard and both service gates.

j. Rewiring and relighting of lock.

The top 8 ft of the upper guide wall was resurfaced with a nominal 8 in. of new concrete. This required removal of approximately 225 cu yd of existing concrete. New wall armor and horizontal corner armor were installed. A 2- to 3-in. overlay of latex modified concrete (approximately 17 cu yd) was applied to the top surface of the upper guide wall. The contractor's bid price for this concrete was $750 per cu yd. The contractor's total bid price for resurfacing the upper guide wall was approximately $350,000.

Resurfacing of the lock chamber monoliths involved removal of approximately 2700 cu yd of concrete and replacing with new concrete. The majority of this concrete was removed by line drilling a series of small holes along the top of the wall, saw cutting around the concrete removal line, and blasting. The contractor used 100-grain Primacord inserted in holes drilled 40 ft into the structure on 8-in. centers. Prior to any blasting, a horizontal saw cut 7 in. deep was cut along the lower work line to prevent the blast from breaking out thin lenses of concrete beyond the work line. The concrete removal line was



Wall armor and concrete reinforcement in place on form

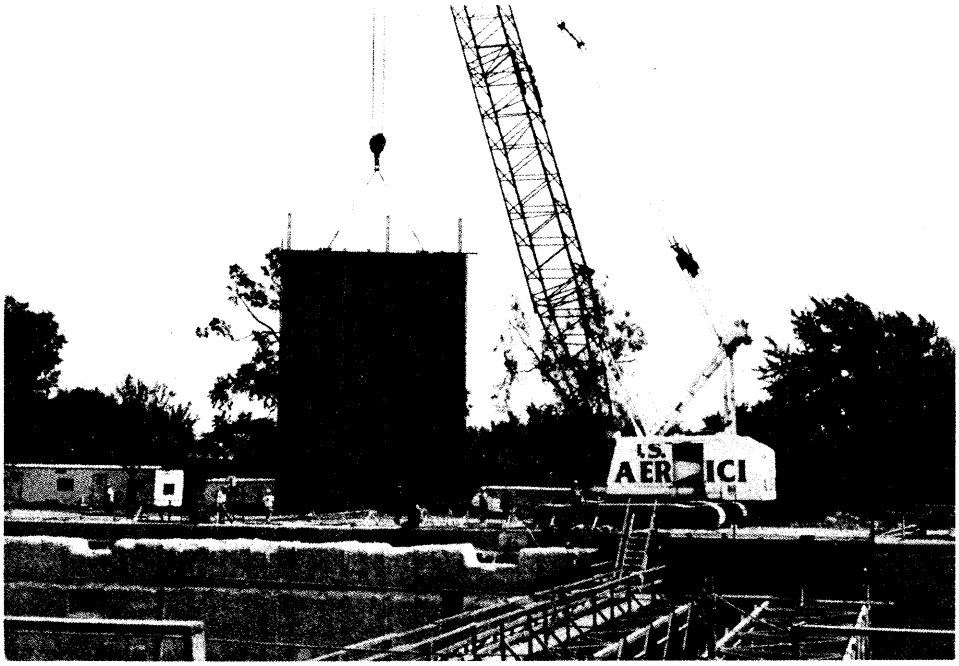
approximately 21 in. off the original face on the riverside wall and 17 in. on the landside wall. The contractor's bid price for removal of concrete in the lock chamber was $162 per cu yd.

Following blasting, the walls were scaled to remove loose concrete still clinging to the wall surfaces. This scaling, normally done by manual processes such as labor crews working from scissor lifts or scaffold platforms with jackhammers and chipping hammers, was in large part efficiently accomplished at Brandon Road using a cutter boom device (see REMR Technical Note CS-MR-1.1).

The concrete did not include reinforcing steel; however, in some areas, a considerable number of steel form ties protruded from the wall after blasting. The replaceable carbide cutting bits on the cutter head of the cutter boom clipped most of these ties off in the scaling operation.

In addition to the scaling operation, the cutter boom was very effective in grinding out soft pockets or honeycombed areas in the concrete structure as detected by Corps and contractor quality control inspectors sounding the walls. By the same token, deeper cuts were easily made by the cutter boom to accommodate steel appurtenances such as lock chamber exit ladders and line hook fixtures requiring deeper embedment in the existing structure than was afforded by the standard removal line.

The newer sidewalk cap over the top of the lock walls included steel sidewalk mesh. In the initial phases of concrete removal, contractor personnel were placing blasting mats on top of the structure and using small explosive charges to fracture the sidewalk and the 2-ft-deep concrete cap required to be removed. After observing how effective the cutter boom was in clipping off steel form ties and grinding up the fractured sidewalk and concrete cap, the contractor experimented with grinding the structure cap and sidewalk without explosive fracturing and found the use of explosives to be unnecessary.



Concrete forming being placed in position on lock wall

Once removal was completed, concrete surfaces were cleaned using a high-pressure water blaster. Holes for dowels to anchor the replacement concrete were drilled using a hydraulically powered gang drill. In general, dowels were installed on 2-ft centers around the perimeter of monoliths and 4 ft on center, each way, in the remainder of the monoliths. Instead of hooked bars, the contractor elected to use straight bars with a nut welded on the end. Dowels were grouted using FASLOC, a resin grout manufactured by Dupont. Selected anchors, two or three per monolith, were load tested to 20 kips using a hollow core hydraulic ram. Approximately 3800 dowels were required to anchor the replacement concrete in the lock chamber resurfacing. The contractor's bid price for these concrete anchors was $15 each.

Wall and armor concrete reinforcement, No. 6 bars on 12-in. centers each way, were installed on the concrete forms prior to placing the form on the lock wall. A truss system was used to span the lock chamber, thus supporting forms on opposing monoliths of each wall simultaneously.

Replacement concrete was placed in a single lift for each 30-ft-wide monolith. This required approximately 85 and 100 cu yd of concrete for landside and riverside monoliths, respectively. Concrete for resurfacing the vertical walls was discharged into hoppers with elephant trunks of varying lengths. Concrete for the 2-ft cap on the top of the lock walls was discharged directly into the form. Internal vibrators were used to consolidate the fresh concrete. Due to the limited space and the depth, there was some difficulty in vibrating the concrete near the bottom of the lift in a few monoliths, which resulted in some honeycombed areas. The perimeter of these isolated areas was saw cut and the concrete chipped to a minimum depth of 2 in. prior to repair.

In an effort to obtain a nonskid surface on top of the lock walls, an abrasive material was broadcast on the concrete surface just prior to final finishing. This material was later exposed by lightly sandblasting the concrete surface.

Maximum allowable temperature of the concrete prior to placing was 88°F, and the actual placing temperature was approximately 85°F. Ambient temperature during most of the concrete placements was in the low 80's. Forms were stripped one day after placing the concrete, and a membrane curing compound was applied to the formed concrete surfaces. At this point, cracking was observed in a number of monoliths. These cracks, which appeared to be thermal in origin, were generally horizontal at a spacing of roughly 5 ft. According to Corps project personnel, there appeared to be more cracking on the shaded side of the lock chamber (riverside wall) as compared to the landside wall which gets direct sunlight. This might be expected since the thermal gradient across the replacement concrete during cooling would be greatest for the shaded wall.

The contractor's bid price for resurfacing the lock chamber was approximately $1.9 million or roughly 25 percent of the total Stage I rehabilitation.

Resurfacing of the upper and lower gate bays and the lower gate forebay required removal of approximately 1000 cu yd of concrete. Using explosives to remove concrete near machinery recesses and gate anchorages in these areas was prohibited in the original design. In these areas, the removal line was drilled much the same as for blasting, and expansive grout (S-Mite) was placed in the holes to fracture the deteriorated concrete face. Initially, this fractured concrete was removed using hand-held and machine-mounted breakers; however, this proved to be very time-consuming. In an effort to increase production, some removal of this concrete using explosives was allowed. In these cases, removal was limited to approximately 5-ft intervals for each blast as compared to full face removal in the lock chamber. Ultimately, the cutter boom proved to be extremely effective in grinding off the fractured concrete in these areas. The contractor's bid price for removal of concrete in these areas ranged from $216 to $675 per cu yd with an average of $413 per cu yd. This average cost was approximately 2.5 times the cost of concrete removal in the lock chamber resurfacing.

Resurfacing the lower guide wall required removal of approximately 1100 cu yd of concrete. Prior to resurfacing, the lower guide wall was stabilized by installing approximately 3500 linear ft of rock anchors. The contractor's bid price for installation and resurfacing of the lower guide wall was approximately $900,000.

Both service gates and the upper guard gate were rehabilitated as part of the Stage I contract. This work included replacing deteriorated sections of the gates, replacing rivets with approved fasteners, sandblasting, painting, etc. The contractor's bid price for gate rehabilitation was $2.4 million or 30 percent of the total Stage I rehabilitation contract.

REFERENCES: a. Mining tool adapted to concrete removal for lock wall rehabilitation project. W. E. Parr. US Army Corps of Engineers, Rock Island District. In: The REMR Bulletin, Vol 2, No. 1, Mar 1985, US Army Engineer Waterways Experiment Station, Vicksburg, MS.